Identifying Core Areas for Chinook Salmon

Chapter 4

Development of Salmonid Conservation Strategies
Phase I, Project No T01426T

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INTRODUCTION

Core areas are the habitats that functionally control population spatial structure (Chapter 1). These habitats are a unique subset of all potential habitats within a river network that are defined by specific characteristics (i.e., patch size, suitability, inter-patch distance, and spatial and temporal persistence). These unique habitats sustain homing, population persistence, and survival. The demographic processes that influence population structure are constrained by habitat spatial organization and temporal disturbance patterns. Therefore, to identify core areas, first we must delineate all potential areas that could provide habitat for key life phases, and second we must identify the specific habitats that have characteristics that match core area criteria. Below we outline a procedure for delineating habitat spatial organization and for evaluating habitat based on the core areas criteria.

Because core areas influence spatial structure at the population scale, the identification of core areas needs to be performed at the spatial scale of a population or stock. The Puget Sound Technical Recovery Team (TRT 2001) delineated the geographic boundaries for Chinook salmon populations in Puget Sound and found that independent population units reside at the scale of an entire river basin or major subbasin. Therefore, the assessment of core areas should be performed at the geographic scale corresponding to a particular population.

IDENTIFYING THE SPATIAL ORGANIZATION OF HABITAT

A combination of digital elevation models (DEMs), other supporting numeric watershed models, aerial photographs, field reconnaissance, and existing studies are used to identify the spatial organization of riverine habitats (Benda et al. in prep.). Spatial organization refers to the types, amounts, spacing, size, and juxtaposition of habitats such as pools, riffles, spawning-size gravel, log jams, floodplains, side channels, and terraces. Although existing spawner surveys in rivers can be used to identify persistent locations of suitable spawning areas (see Chapter 3), often spawner surveys are limited to large rivers, and other features important to riverine ecosystems are not surveyed, including log jams, floodplains, and side channels, etc.

DEMs can be used to stratify channel networks according to gradients (gradient can be used as a surrogate for grain size, channel morphology, and hence fish habitat types; Sullivan et al. 1987). Other watershed models (ESI 2002), coupled with DEMs, can be used to predict location and size of alternating canyons and floodplain segments, and the location of geomorphically significant confluences (the latter based on Benda et al. in press a, b). Although the model predicts the probability of encountering geomorphic effects for all confluences in a river network, this study suggested that a P value greater than 0.8 was associated with significant patches of spawning habitats in several of the rivers studied. This approach was used to delineate the spatial distribution of channel gradients, valley widths (i.e., channel confinement), and significant tributary confluences for the Snoqualmie, Skykomish, Green, and Cedar rivers. In addition, existing studies (e.g., Perkins 1993, Booth et al. 1991) and limited analysis of aerial photographs were used to identify large and persistent landslides and to confirm geomorphic effects of confluences and canyon mouths in the King County rivers described in this report.

Predictions of the large-scale spatial distribution of river habitats, as described above, can be represented on maps, as illustrated for the rivers examined in this report. However, numeric indices representing tributary junction density and variation in valley widths can be generated to provide information on how habitat heterogeneity may vary within and across watersheds (Benda et al. in prep.).

IDENTIFYING CORE AREAS FROM SPATIAL ORGANIZATION OF HABITATS

APPROACH

The identification of core areas should be performed at the geographic scale of a specific population, which generally equates to the scale of a major river basin. The known geographic distribution of most salmon populations is reported by fisheries management agencies (e.g., see TRT 2001, Washington Department of Fisheries et al. 1993). The spatial organization of habitats and the geomorphic features that form habitat within a specific basin need to be delineated and mapped according to the methodology defined above and in Chapter 2. The maps produced by the geomorphic analysis provide the template for delineating core areas.

Core areas are the subset of habitats within river segments and associated features that most closely match the core areas criteria. Core areas are habitats that are:

- biologically suitable (capable of supporting life phase function),

- temporally persistent (spatially fixed and have a high potential for habitat rejuvenation),

- located within or adjacent to a migratory corridor,

- accessible most of the time (not dependent on low return interval events to facilitate access), and

- cumulatively large (support significant portion of population).

Core areas are delineated by an evaluation of all potential habitats within a basin to determine how well the habitat characteristics compare to the criteria listed above.

INFORMATION NEEDS

The information needed for this assessment includes the following:

- Output from analysis of habitat spatial organization (i.e., maps that display the spatial organization of potential habitats and the location of all geomorphically significant river features).

- Information that could be used to evaluate habitat suitability and size (e.g., aerial photographs, channel typing maps, habitat condition inventories, channel geomorphic surveys).

- Information that could be used to evaluate passage capability (e.g., stream flow records, flow prediction models [IFIM, basin area and flow regressions], and fish barrier surveys).

CORE AREA EVALUATION

The evaluation is performed for each life phase that is known or suspected to influence population spatial structure. We believe that any migration or deliberate movement behavior during a life phase that favors growth and survival of the population probably influences population spatial structure. Therefore, habitats that most closely match the habitat characteristics that are required for a given life phase would be designated as core areas. Below is a description of the habitat characteristics and the sequence of evaluation for delineating core areas for Chinook salmon spawning. We believe a similar evaluation could be performed for other life phases or species given the incorporation of specific information on habitat suitability and the association between a given life phase and habitat features and processes.

Habitat Suitability

Evaluating habitat suitability for a given life phase is the first step in the evaluation because only habitats that are capable of supporting life phase function are potential core areas. For Chinook spawning, habitat suitability is simply the presence of gravel patches within or associated with the habitat-forming features listed above. Initially, a simple designation of habitat presence within a channel segment is all that is needed to verify habitat suitability by location. However, if data are available, an estimate of the proportion of a channel segment (i.e., proportion of segment length or area) that contains suitable spawning habitat can be used to determine the amount of habitat available. Habitat size and quantity are helpful for evaluating relative importance to the population.

Habitat is rated suitable or unsuitable.

Habitat Persistence

Habitat persistence relates to the spatial and temporal reliability of a river feature (i.e., the ability of the feature to maintain suitable habitat over time. Persistence rankings are based on the relative potential of habitat forming features to be spatially fixed and their relative frequency of habitat rejuvenation. For example, tributary junctions or bedrock outcrops are spatially permanent features whereas log jams and channel meanders are ephemeral features that form and disappear over time. Fluvial landforms, including spawning areas and enlarged floodplains, that form in association with tributary confluences reflect sediment transport and deposition processes that continually shape and rejuvenate those types of habitats. In Chapter 2, we discuss how specific river features can form core areas for spawning. Of the seven features that can form habitat, we rank tributary confluences and floodplain segments as having the greatest potential to maintain large, persistent spawning patches (Table 1). Bedrock outcrops and boulder clusters are spatially fixed, but habitat rejuvenation is limited because these features often occur in confined channels where sediment transport is high. Landslides are also fixed at a specific location, but the frequency of their activity is variable. Log jams and channel meanders tend to be short-lived compared to other features, but their type (i.e., channel spanning versus lateral on bars) and location (at segment scale) are generally predictable. Because these features are continually being formed in response to variations in wood and sediment supply, the habitat associated with these features is continually rejuvenated. Note, any one of these features can be a dominant

former of habitat and affect spatial organization of habitats depending on the size, shape, and geologic characteristics of a basin (see Chapter 2).

Persistence is rated high or low (Table 1). Ratings are indicators of the relative persistence of a feature.

Table 1. **River feature persistence rating. Ratings are shown in parentheses.**

		Frequency of Habitat Rejuvenation	
		Low	High
Spatial Permanence of Feature	**Low**		Log jams Channel meanders (Low)
	High	Bedrock outcrop Landslide (Low)	Tributary jct. (P > 0.8) Canyon mouths Floodplains (High)

Habitat Proximity to Migratory/Movement Corridor

The proximity of habitat to the migratory/movement corridor is an indicator of probable use and connectivity. Habitats that are located on the mainstem or in a large tributary are more likely to be occupied and function as core spawning areas for Chinook salmon than are habitats that occur long distances off of the migratory corridor. Similarly, habitats that are in close proximity to each other (i.e., inter-patch spacing is small) have a higher probability of use than do habitats that are spread far apart.

All habitats that are biologically suitable and that are deemed accessible within a study watershed should be ranked in terms of their distance from the mainstem or major tributary. The probability that each habitat will function as a core area is assumed to be directly related to the habitat proximity to the migratory/movement corridor.

Proximity values may be either categorical (close, moderate, far) or actual measures of distance.

Habitat Accessibility

Habitats that are normally accessible during the migration or movement period are more reliable and more likely to function as core areas than are habitats that require specific conditions (e.g., high stream flows) to enable access. Habitats that are dependent on low-return-interval events to facilitate access are probably not functioning as core areas because they are unreliable for the population.

Physical obstacles and channel segments that require high flows to facilitate fish passage are the most common features that limit access to suitable habitat. We assume all habitats that

require access flow events larger than a 2-year return interval are probably not functioning as core spawning areas for Chinook salmon. This event interval is based on the assumption that some proportion of any given brood year will probably gain access to the habitat because of the typical multi-age class composition of Chinook populations. Habitats that are only accessible during larger flow events (i.e., return intervals longer than 2 years) would not be capable of sustaining population structure because of frequent disruptions in homing.

Methods for evaluating flow dependent passage may be found in reports by Bovee (1982) and Powers and Saunders (1998).

Habitat is rated accessible or not accessible.

Habitat Size

Habitat patch size is an approximate measure of production potential or capacity. Habitat size may be expressed in terms of area, length, or as a percentage of the total suitable and accessible habitat in a watershed. In general, habitat patch size increases downstream with decreasing channel gradient (see Chapter 2).

Synthesis

The goal of the core areas evaluation is to delineate the relative potential for all habitats within a watershed to function as core areas. The core area potential is based on the ranking of each habitat relative to the core areas criteria. Each habitat's criterion ratings should be placed on a map and on an associated table for synthesis. The first cut in the analysis is to eliminate all habitats that are found to be unsuitable or inaccessible. The next step is to sort the remaining habitats into two groups based on persistence. Then sort the habitats in the two persistence groups based on a combination of proximity and size. For Chinook salmon spawning, we suggest that all habitats that have high persistence, form large spawning areas, and are located on or near the migratory corridor have the highest probability of being core areas. Habitats with proximity and size values similar to those of the above group but that have fair persistence are ranked second in terms of probability of being a core area. All other habitats (i.e., small size, far from corridor, or both) are ranked as having the lowest probability of being a core area.

The specific values used for breaking habitat size and proximity into large versus small and close versus far, respectively, are not defined. The best guide is to look at the distribution of habitat sizes and locations to define logical break points. Also, look at the geographic clustering of habitats and evaluate size and proximity relative to the combined size and distribution of clusters.

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